Power factor correction

Often, we need to fix it ...

just add a capacitor or inductor to tune it to resonance ..

Example:

You are setting up a radio transmitter at 1 MHz. (AM broadcast).

The antenna is too short, so it has an impedance of $5 - j500$

What voltage and current are necessary to transmit 5000 watts?

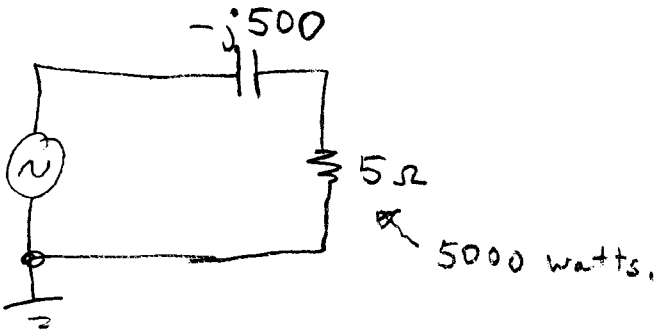
What is the power factor?

How can we fix it?

What voltage and current are required now?

Hw –
10.39

Equivalent circuit:



We need 5000 watts in the resistive part:

Find V:

$$P = \frac{V^2}{R} \rightarrow V^2 = PR \rightarrow V = \sqrt{PR}$$

$$V = \sqrt{(5000)(5)} = \sqrt{25000} = 158.1 \text{ volts}$$

Find I:

$$P = I^2 R \rightarrow I^2 = \frac{P}{R} \rightarrow I = \sqrt{\frac{P}{R}}$$

$$I = \sqrt{\frac{5000}{5}} = \sqrt{1000} = 31.62 \text{ Amps}$$

Check: $P = VI$

$(158.1)(31.62) = 5000$ ✓

check: $R = \frac{V}{I}$

$\frac{158.1}{31.62} = 5$ ✓

But <u>this is not the answer</u>.

It is only the resistive part.

Capacitor voltage ---

Current is 31.62 Amps (same as resistor)

$V = I Z$

$= (31.62)(-j500)$

$V = -j15811 \quad = 15.8\,kV \angle -90°$

So -- voltage out of generator =

$= V_C + V_R = 15811 \angle -90° + 158.1 \angle 0°$

$V_{generator} = 15812 \angle -89.4°$

Real power = 5000 watts

Imaginary power = 500,000 VAR

Complex "power" ≈ 500,000 VA

Generator must supply 15812 volts

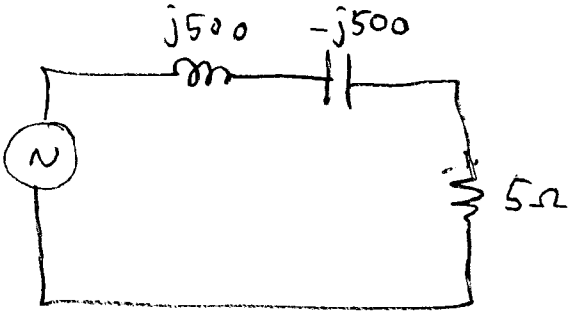
at 31.62 Amps (1 0)

to put out only 5000 watts ---

power factor = $\cos(\theta) = .01$

To fix it --- put an inductor either in series or parallel ---

Series:



$Z_L = j500\ \Omega$. — to cancel the $-j500$ of the capacitive part of the load.

$$Z_L = jWL \rightarrow L = \frac{Z_L}{jw}$$

$$L = \frac{j500}{j(2\pi 10^6)} = \frac{500}{2\pi 10^6} = 79.58\ \mu H.$$

(w)

Now, the generator only needs to supply 158.1 volts

So --- Real power = 5000 watts

Imaginary power = 0.